



University  
of Glasgow

## HIGH FREQUENCY COMMUNICATION SYSTEMS

### Lecture 12 - Finishing it off...

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- Going the extra mile
- Disaggregation
- Thoughts ...

**High-Frequency Communication  
Systems**



METASURFACES

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- Mould the shape of a wavefront
- Challenge — Below optical frequencies, the EM wave loses its coherence when we move away from the source

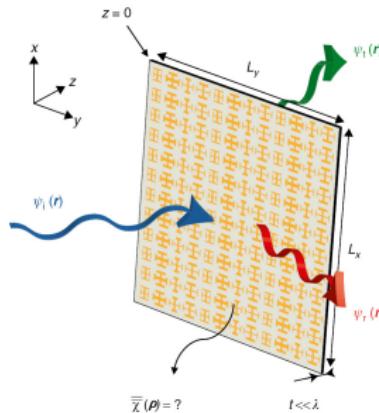


Figure 1: A metasurface illustration, from [Achouri, Karim and Caloz, Christophe. Nanophotonics, vol. 7, no. 6, 2018].

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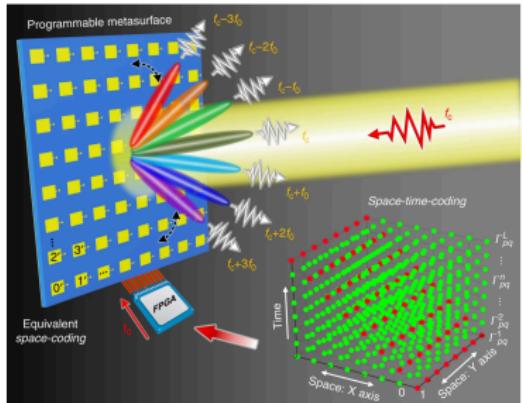
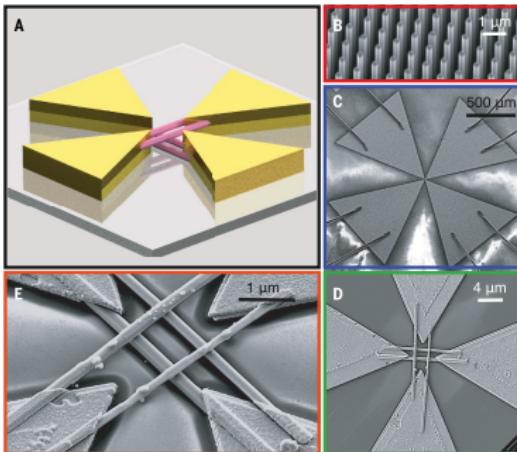


Figure 2: Programmable Metasurface, from [Zhang, L., Chen, X.Q., Liu, S. et al. Nat Commun 9, 4334 (2018)].

**TERAHERTZ APPLICATIONS**

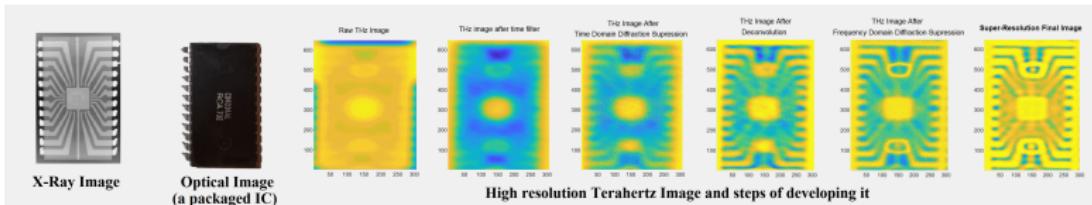
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Relying on the principle of reciprocity, we can use photoconductive antennas to detect THz radiation.



**Figure 3:** A polarisation sensitive cross-nanowire THz detector [Peng et al., Science 368, 510–513 (2020)].

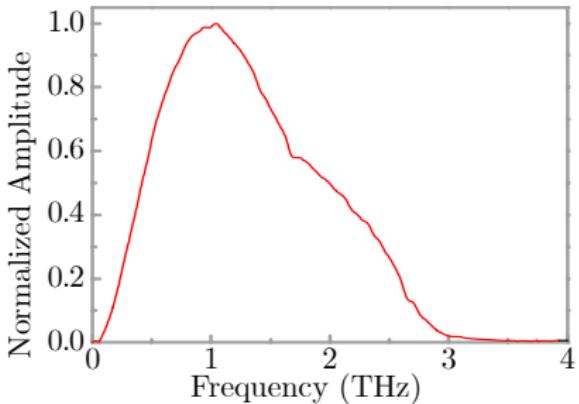
- THz waves have the ability to **see through** apparently opaque objects.
- This is done in a non-ionising manner
- Through image processing, we can achieve high-resolution imaging through THz waves.



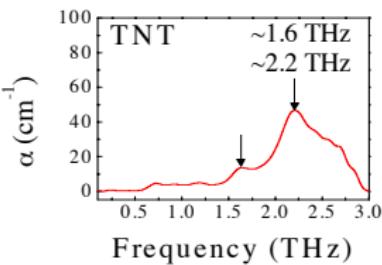
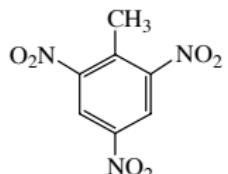
- THz time-domain spectroscopy (THz-TDS) is a well-known method for characterising the material properties of different substances

- Attractive applications in explosives detection, counterfeit drug discovery and health monitoring of plants

- The Biggest feature is again, the non-ionising nature of THz waves
- Common substances such as H<sub>2</sub>O and N<sub>2</sub> have strong absorption spectra



2,4,6-Trinitrotoluene (TNT)



**SOFTWARE DEFINED RADIO**

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- A communication system consists of many layers of operations.
- The physical layer is the most important of all.
- Typically, physical layer processing is done via dedicated hardware
- Radio is the technology through which signals are wirelessly transmitted and received
- Software-defined radio has some or all physical layer functions implemented via software

# SOFTWARE DEFINED RADIO

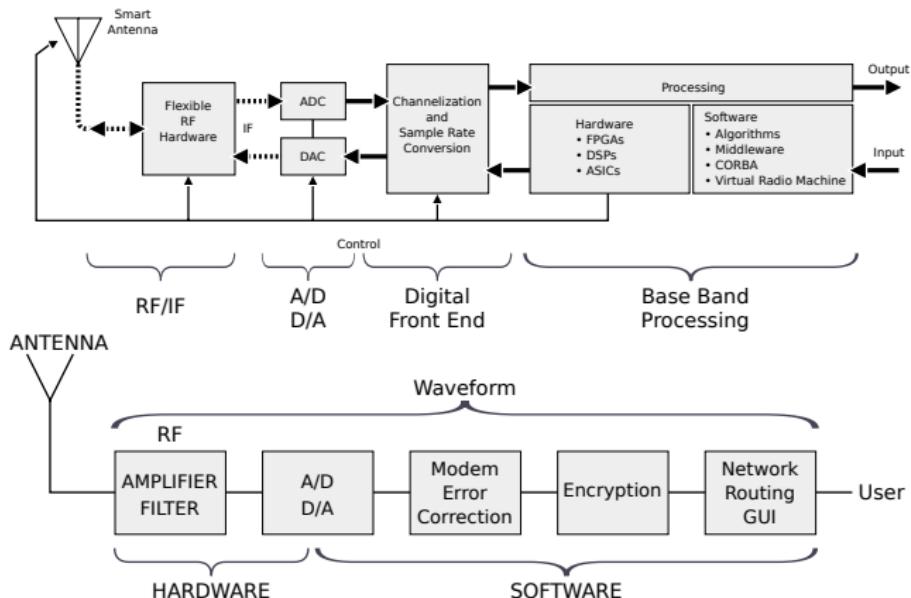


Figure 4: A Typical SDR workflow

- A graphical user interface consisting of *flowgraphs* through which different signal processing functions such as analogue-digital conversion can be performed.
- Some additions let us write **Python** codes within each block
- The software is meant to interface with Universal Software Radio Peripheral (USRP) modules to construct a complete communication system.

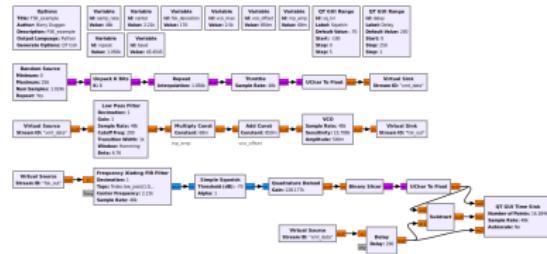


Figure 5: GNU Radio Interface.